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ABSTRACT

Thirty college undergraduates participated in a study of the effects of acoustic and visual interference on the recall of word and picture triads in both short-term and long-term memory. The subjects were presented 24 triads of monosyllabic nouns representing all of the possible combinations of presentation types: pictures, printed words, and spoken words. Each triad presentation was followed by a visual, acoustic, simultaneous, or no interference task. After each triad and after the complete presentation, the subjects free-recalled as many nouns as possible, indicated presentation type, and rated their confidence in the presentation type. The results showed that in short-term memory, picture recall was superior to that of both printed and spoken words under conditions of acoustic and simultaneous--but not visual--interference. The lowest recall in both long-term and short-term memory was found for spoken words under the acoustic interference condition. (FL)

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Interference Effects on the
Recall of Pictures, Printed Words
and Spoken Words

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ABSTRACT

In an extension of work of Pellegrino, Siegel, and Dhawan, nouns were presented in triads as pictures, printed words or spoken words and followed by visual, acoustic, simultaneous, or no interference. Recall, presentation type, and confidence ratings were elicited after each triad. After all triads were presented, participants free-recalled as many nouns as possible, indicated presentation type, and rated confidence as measures of long-term memory. In short-term memory, pictorial superiority was noted under conditions of acoustic and simultaneous interference but not after visual interference. Long term memory data showed superior recall for pictures. These results were compared to Pellegrino et al. research and to Paivio's dual coding hypothesis, and differences in patterns of short term and long term memory data were interpreted within a levels of processing framework.

Interference Effects on the Recall
of Pictures, Printed Words and Spoken Words

In recent years there has been a resurgence of interest in the role of imagery in human memory spurred by the dual coding hypothesis of Paivio (1971). Paivio's basic premise is a simple one: Pictorial stimuli are automatically labeled on input and stored in separate imaginal and verbal systems. Thus, each picture that is capable of being labeled is stored twice. Words, on the other hand, may be stored in both systems only if they are "imaged".

It is important to note that Paivio defines his two systems very broadly. An image can be a picture or a sound or even perhaps a taste, while the verbal store, on the other hand, is construed broadly to mean a language store. In Paivio's (1971) words, image refers "...to concrete imagery, that is, nonverbal memory representations of concrete objects and events, or nonverbal modes of thought (e.g., imagination) in which such representations are actively generated and manipulated by the individual. This will usually be taken to mean visual imagery, although it is clear that other modalities (e.g., auditory) could be involved and when they are, this must be specified. Imagery, so defined, will be distinguished from verbal symbolic processes, which will be assumed to involve implicit activity in an auditory-motor speech system." (p. 12).

Pellegrino and his associates (Pellegrino, Siegel, & Dhawan, 1975, 1976a, 1976b) have interpreted Paivio's systems more narrowly as visual and acoustic and operationalized them as pictures and visually presented words. Having thus defined the two systems, they have studied the effect of acoustic and visual interference as well as simultaneous and sequential combinations of both on the recall of word and picture trials in both short-term memory (STM) and long-term memory (LTM). In general, their results support the dual coding interpretation.

They report that visually presented words and pictures are both recalled at high levels following visual interference (words somewhat better) as a result of dual storage of pictorial stimuli. Visual interference affects only the non-common channel or system (i.e. visual) and not the shared acoustic system. Acoustic interference, on the other hand, causes a decline in recall of both visually presented words and pictures, but words suffer a great deal more in recall performance. This difference, it is argued, is due to the fact that pictures have been also coded within and are available through the visual store while words are restricted to only the acoustic store. Pellegrino et al.'s interpretations give rise to two broad questions. First, can visually presented words be presumed to be acoustic in nature? Second, what is the efficacy of Pellegrino et al.'s interpretations if presentation modality is varied within, rather than across triads?

In reference to the first issue, the current investigation included auditorily presented words as stimuli in addition to the pictures and visually presented words of Pellegrino et al. Auditorily presented words might reasonably be presumed to be "more acoustic" than visually presented words, that is, less likely to be dually encoded. If this is so, one would expect that auditorily presented words should suffer more from subsequent acoustic interference than visually presented words. On the other hand, visually presented words, even if not stored as visual copies (Light, Berger, & Bardales, 1975) may still be represented with enough visual imagery to suffer more in the presence of visual interference relative to auditorily presented words.

The second major question was addressed through the use of mixed modality triads in presentation rather than single modality triads such as those used by Pellegrino. This method of presentation is necessary in order to permit the evaluation of memory for presentation modality vis a vis the levels of processing theory (Craik & Lockhart, 1972).

Also, of specific interest in this investigation was the effect of interference tasks on short term versus long term retention. Gotz and Jacoby (1974) have shown that when no interference follows a short list, and the participants know that this will be the case, immediate recall is high but subsequent recall is low when compared to groups that had interference tasks following presentation. Similarly, Pellegrino and his associates (1976a) found that, within presentation types, those conditions which produced the highest recall in short term memory produced the lowest recall in long term memory. This has been interpreted as the result of processing effort at a deeper level to meet the interference. In the present experiment, it was predicted that the order of recall by interference task will be reversed from short term to long term memory within presentation types. Thus, for example, acoustic interference, which produces poor short-term performance with visually presented words relative to visual interference, should produce superior recall in LTM.

Method

Materials

Materials for the experiment were a pool of 75 monosyllabic nouns (e.g., bird, star) taken from the beginning vocabulary words of the System I Reading Program of the Omaha Public Schools. Each word has a counterpart picture with a recognizability of 90% or better for first grade students. Visual stimuli were reverse field slides (yellow on black) containing either a line drawing or block print word. These stimuli have been used in previous research (Bruning, Burton, & Ballering, in press). Auditory stimuli were recorded by a male adult.

Participants

Participants were 30 undergraduate students drawn from introductory Educational Psychology classes at the University of Nebraska-Lincoln who

could elect to participate to partially fulfill a course research requirement.

Procedures

The experimental task consisted of the presentation of 24 triads of mixed presentation types, each followed by an interference task. The 24 triads represented all the possible combinations of three types--picture, printed, and spoken--taken three at a time, except that the three single presentation type combinations (e.g., picture, picture, picture) were eliminated. Interference tasks were visual, acoustic, simultaneous visual and acoustic, or no interference. In order to allow some counter-balancing of interference task order while still allowing for ready scoring of participant responses, the combinations were arranged into four blocks of trials such that each block involved the presentation of six stimuli of each type.

Participants were seated at a table, and the experimenter explained the general procedures to each participant including a description of the interference tasks and a presentation of a noun in each presentation form, one at a time. After each presentation, the participants were asked to recall the noun, the type of presentation and to state their confidence in their choice for type of presentation as required by the experimental task. Following this, one of each type of interference task was presented for practice.

The participants were then presented with a "warmup" triad that required a visual interference task. As part of the warmup activity, the participants were required to recall the triad nouns, identify the type of presentation for each and to state their confidence in their choice of presentation type. The participants were cautioned at this time to be sure to state their confidence for the type of presentation and not for the noun itself. They were also instructed to work on the interference tasks as rapidly as possible despite the fact that it would lower their ability to recall and to refrain from vocalizing or "mouthing" the nouns.

Printed word and picture stimuli were displayed for .5 sec. by a Lafayette 41010 (KT-800) automatic projection tachistoscope from a distance of about 2 m. with stimuli subtending a visual angle of approximately 5 degrees. Spoken words were presented from an audio cassette tape via a Wollensak 2551 tape recorder and earphones. Because of the difficulty of "presenting" an auditory stimulus for .5 sec., that interval was allowed for processing but only approximated as a presentation interval. An interstimulus interval of 1.0 sec. (the system limit) was used, making the total presentation time for each triad about 3.5 sec. from the opening of the tachistoscopic lens for the first stimulus to the closing for the third. These intervals were controlled by silent cues recorded on the audio tape and monitored by the tape recorder.

The tape also contained the instructions which controlled the participant's actions. "Get ready" preceded each triad and served to cue the student, "begin task" followed each triad and cued the student to begin working on his/her assigned interference task, and "begin recall" served to notify the student that his or her 10 sec. of interference had elapsed and (s)he should recall the triad.

The interference tasks used for the experiment were similar to those used previously by Pellegrino et al. (1976a) with the addition of a no interference condition. For the visual interference task, Pellegrino et al.'s modification of the embedded figures task was presented with the participant instructed to circle the embedded figure. The acoustic interference task involved counting backwards by threes rather than the sevens used by Pellegrino et al.

In the simultaneous interference task, the participants were required to search for an embedded figure and count backwards at the same time. Each interference task, as well as the no interference condition, lasted for 10 sec.

Beginning numbers and/or figures to be used for each block were contained in a booklet given to each participant. (In order to vary the order of interference tasks across the experimental presentation it was not possible to present the numbers in the most desirable manner, viz. on the tape itself). During the interference tasks, the participants were instructed to work as quickly as possible. Those participants who located the embedded figures contained in the visual or simultaneous conditions prior to the instruction to begin recall were required to proceed to the next figure.

To control for possible confounding of interference task by order, the 16 possible orderings of the four interference tasks were each presented at least once across the 30 participants with 14 of the tasks drawn at random without replacement from the 16 combinations presented twice.

Recall was elicited by instruction from the tape. Each participant orally recalled the nouns, the type of presentation, and her/his confidence in the type of presentation for that noun on a 5 point Likert scale. This information was recorded by the experimenter. Following all 24 triads, the subject was engaged in conversation for about 30 sec. and then instructed to free recall in writing as many nouns as possible and to indicate presentation type and confidence in presentation type as before.

Results

The design for both the STM and LTM phases was a 3 x 4 univariate ANOVA. Within-subject variables were presentation type (picture, printed word, spoken word) and type of interference (visual, acoustic, simultaneous, or no interference). Within this design the dependent measures for both phases were (a) frequency of noun recall and (b) frequency of noun recall with the type of presentation correctly identified. Because several subjects had zero recall under several conditions in LTM, confidence ratings for correctly identified

nouns with type of presentation were analyzed only in STM. This analysis was a separate 3 x 4 univariate ANOVA with repeated measures on all factors.

Table 1 presents the means for frequency of words correctly recalled and frequency of words correctly recalled with the presentation type also correctly identified. Alpha levels for all tests of significance were set at .05 and Tukey's method employed for post-hoc analysis of significant differences.

Insert Table 1 About Here

In STM, tests for main effects of interference conditions, $F(3,87)=42.24$, $MSe=1.38$, and modality, $F(2,58)=13.47$, $MSe=1.21$, were significant for frequency of recall but qualified by a significant interaction, $F(6,174)=4.19$, $MSe=1.0$. Inspection of Table 1 shows that the acoustic and simultaneous interference task produced much lower performance ($\bar{X}=4.11$ and 4.07) than the condition of no interference ($\bar{X}=5.66$). The visual interference task ($\bar{X}=5.35$), however, produced the only slightly lower recall than the condition of no interference. The interaction may be seen to be attributable to the fact that under acoustic interference and simultaneous interference, picture recall was significantly higher than either printed or spoken word recall. In contrast, no differences were significant under visual interference conditions.

In LTM only the main effect of modality was found to be significant for frequency of words correctly recalled, $F(2,58)=84.69$, $MSe=.87$. Post-hoc comparisons indicated that pictures were recalled better than either printed words or spoken words within each interference condition. Interference conditions did not differ.

The additional requirement to name the presentation type did not, in general, produce a pattern of results that differed from that of simple recall enough to warrant a separate discussion of results or tabling of means. There was one notable exception however; the recall of printed words under visual interference.

While naming the presentation type reduced mean picture recall from 5.33 to 5.20 and mean spoken word from 5.53 to 5.20, printed words declined from 5.20 to 4.26. Thus while pictures, printed words, and spoken words did not differ for simple recall, post hoc analysis indicated that printed words were recalled significantly fewer times with correct presentation type identified than either pictures or spoken words under the condition of visual interference.

For the confidence ratings in STM (see table 2) significant effects were present for interference condition, $F(3,84)=9.62$, $MSe=.38$, and for modality, $F(2,56)=11.58$, $MSe=.28$. The post-hoc analysis showed confidence ratings to be significantly superior for pictures when compared to printed words under simultaneous interference condition. Pictures were also superior to printed words under acoustic and visual interference conditions. On the interference dimension, the majority of variance was accounted for by the difference between the no-interference condition and the other groups.

It will be recalled that a general prediction was made, based on the levels of processing approach, that those conditions which produced the highest recall in STM would produce the lowest LTM. Inspection of Table 1 reveals that, with the exception of no interference, the remaining three conditions tended to reverse themselves from STM and LTM for both groups. Thus, visual interference, which permitted the highest recall in STM, produced the lowest recall in LTM with the no interference condition removed.

A consistent deviation from the prediction is to be found for spoken words under acoustic interference. This condition produces the lowest recall in both LTM and STM.

Discussion

The results of the current investigation, which overlaps Pelligrino et al. but varies modality of presentation within, rather than across triads, are contradictory to that body of research in several key areas. In STM the superiority of

pictures over printed words (spoken words as well) under conditions of acoustic and simultaneous interferences is replicated but unlike the earlier work of Pellegrino et al. is not easily explained in terms of Paivio's (1971) dual coding hypothesis. Such a position would hold that single modality interference would affect recall only if memory was coded within that channel and that channel alone. This was generally found to be true with visual interference producing no differences between the presentation types and only slightly lower performance overall than no interference. Acoustic and simultaneous interference, on the other hand, do lower recall for printed words and spoken words relative to pictures, interfering with the single channel of coding for printed words and spoken words while the "dual coded" pictures, presumably represented in two channels, are affected to a much lesser extent. Pelligrino et al. (1975) found support for this interpretation in that acoustic interference had little effect on picture recall but combined visual-auditory interference depressed picture recall while having no more negative effect on word recall than the auditory task alone. Moreover in their (1976a) study they reported that word recall was actually better under dual distraction than with acoustic distraction. In the current investigation picture recall did not differ under acoustic and simultaneous conditions. This indicates that interference with both channels of storage, did not effect recall for pictures anymore than interference with one channel viz. auditory. This finding seriously undermines the dual coding interpretation of modailty differences and favors a semantic-based interpretation (e.g. Anderson & Bower, 1973; Plyshyn, 1973). However the failure of the visual interference task to produce recall significantly different from no interference may reflect a faulty line of reasoning suggested by Wickens (1970) in the area of verbal interference namely that in research involving interference it is often assumed that "...any visual task would necessarily interfere with any image processing" (Kieras, 1978 p. 547, author's italics). The Pellegrino et al. embedded figures task may simply not interfere

with the line drawings used as stimuli. Certainly a comparison of the recall under visual with no interference suggests that the acoustic and visual interference tasks were not equal: acoustic appears to have been much more powerful.

The visual interference task was not totally without effect, however. As indicated, the ability of subjects to successfully name the presentation type for correctly recalled printed words was almost one full word less than simple recall. Thus while simple recall for the three presentation types did not differ under visual interference, printed words were recalled less well than the other presentation types under this condition when the additional requirement to name the presentation type was added. Moreover in those cases where subjects correctly recalled printed words but confused the presentation type, errors were not significantly different than chance; that is about half the errors were incorrectly naming picture and half spoken words. The requirement to name presentation type was included to investigate possible confusions in retrieving "dual coded" pictures. Such confusions were not detected. Thus the only evidence which appears to suppose dual coding in the current investigation is in a most perplexing instance: printed words.

On the confidence dimension, it was assumed that interference with either of the two channels of picture coding would affect the confidence in the presentation types even if recall was not affected. In fact the confidence for pictures was higher than either printed words or spoken words for each interference condition. Confidence was significantly lower for printed words when compared to pictures under acoustic, visual, and simultaneous conditions which supports the contention that printed words may be at least weakly coded in both channels.

A last area of interest was the comparison of the pattern of recall performance from STM to LTM. In line with Craik and Lockhart's (1972) levels of processing approach, it was predicted that those interference conditions which maximized performance in STM would minimize it in LTM. In the context of

the levels of processing theory this may be explained in terms of high interference producing greater processing effort and, hence, a deeper level of storage when compared to low interference conditions. Levels of processing theory generally predicted well in terms of simple ranking for conditions of moderate interference in the current experiment except for extremely the no interference condition. For each presentation type, the no interference condition produced the highest recall in both STM and LTM. Gotz and Jacoby (1974) reported that recall after no interference was highest in STM but lowest in LTM when compared to other interference tasks if the participants knew that no interference would follow. They did not find this reversal if the subjects did know that no interference would follow. In the current investigation however, the major finding vis a vis the levels of processing theory or that reliable differences between interference conditions in STM are not found in LTM. This while statistically reliable reversals are not present it is apparent that the advantage of little or no interference in STM (or the disadvantage of high interference) is not evident in LTM.

Footnotes

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Table 1
Mean words recalled in STM and LTM

		Interference Task				
Presentation type		Acoustic	Visual	Simultaneous	None	Total
STM Recall						
Picture	$\bar{X}$	4.93	5.33	4.80	5.80	5.21
	SD	0.98	0.95	1.27	0.55	
Printed	$\bar{X}$	3.86	5.20	3.73	5.56	4.58
	SD	1.33	0.99	1.38	0.77	
Spoken	$\bar{X}$	3.56	5.53	3.70	5.63	4.60
	SD	1.69	0.77	1.53	0.71	
Total		4.11	5.35	4.07	5.66	
LTM Recall						
Picture	$\bar{X}$	2.16	1.93	2.10	2.16	2.08
	SD	1.59	1.52	1.44	1.55	
Printed	$\bar{X}$	0.93	0.76	0.90	1.06	0.83
	SD	1.33	0.85	0.88	1.14	
Spoken	$\bar{X}$	0.50	0.56	0.66	0.66	0.59
	SD	0.73	0.89	0.80	0.80	
Total		1.19	1.08	1.22	1.29	

Note. Maximum = 6

Table 2
Mean Confidence Ratings in STM

		Interference Task				
Presentation Type		<u>Acoustic</u>	<u>Visual</u>	<u>Simultaneous</u>	<u>None</u>	<u>Total</u>
STM Confidence Ratings						
Picture	$\bar{X}$	4.54	4.71	4.62	4.85	4.68
	SD	0.61	0.56	0.71	0.31	
Printed	$\bar{X}$	4.21	4.35	4.14	4.71	4.35
	SD	0.83	0.76	0.99	0.41	
Spoken	$\bar{X}$	4.32	4.57	4.18	4.73	4.45
	SD	0.79	0.54	0.99	0.42	
Total		4.35	4.54	4.31	4.76	

Note: Data from one participant with no recall under two conditions are excluded from Table 2: N=29.